Eastern Gamagrass
For Forage, Soil Improvement, and Buffer Strips

IN THIS ISSUE

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Restrictive Soil Features:
Eastern gamagrass can have an impact

By John Davis, Soil Resource Specialist, USDA NRCS Mid-Atlantic IRT, Beltsville, Maryland.

A ***soil map assessment*** of the area including the states of *Delaware, Maryland, New Jersey, New York, Virginia Pennsylvania, and West Virginia* revealed the common occurrence of soil restrictive features. The assessment is based on the predominant soil components of the area.

- 25% have acid restrictive features within 150 cm of the soil surface
- 11% have root and water penetration restrictive features within 50cm of the surface
- 39% have root and water penetration restrictive features at depths 50-100cm
- 60% have root and water penetration restrictive features at depths 100-150cm
- 25% have saturation restrictions, moderately well to somewhat poorly drained soils
- 16% have saturation restrictions, poorly to very poorly drained soils

Eastern gamagrass is well suited for use on many soils with restrictive features. The plant is able to establish itself under less than favorable conditions. The unusual ability to extend roots into acidic, saturated, or penetration resistant layers will help ameliorate these restrictions over time. Gamagrass can help improve soil quality on damaged or naturally less productive landscapes.

Restricted Soils are soils that have layers that roots and water cannot easily penetrate. The nearly continuous layer has one or more physical, chemical, or thermal properties that significantly reduce the movement of water and air through the soil or that otherwise provide an unfavorable root environment. Cemented layers, dense layers, frozen layers, strongly contrasting textures, and dispersed layers are examples of soil layers that are restrictions. Restrictive features are often associated with increased production costs and reduced productivity.

More on soil quality can be found in the USDA NRCS "Guidelines for Soil Quality Assessment in Conservation Planning, <http://www.statlab.iastate.edu/survey/SQI/Assess.htm>.

Quality Harvest

Eastern gamagrass forage quality as influenced by harvest management

Paul Salon, Research Agronomist, USDA NRCS, Big Flats Plant Materials Center, Corning, New York.

Eastern gamagrass (*Tripsacum dactyloides* L.) is a palatable digestible perennial warm season grass which can be used for hay, haylage and in managed pastures. The forage quality of eastern gamagrass was evaluated at Corning, NY in 1997 and 1998 for CP, NDF, ADF, lignin, IVTD and digestible NDF. The cv 'Pete' was evaluated at three 1st cutting dates, starting 6/13/97 and 5/28/98 and taken at three, weekly intervals and three second cutting intervals (4, 5 and 6 weeks).

Reproductive and vegetative tillers of six gamagrass clones plus cv 'Pete' were evaluated for three 1st cutting dates. There were significant differences between the genotypes for vegetative tillers for all variables measured except for ADF in 1997 and for lignin in 1998. For reproductive tillers only NDF and lignin were not significantly different in 1998. This variability indicates the potential for forage quality improvement of eastern gamagrass by plant breeding.

Forage quality decreased with later cutting dates (Table 1). There were significant differences between cutting dates for genotypes of both tiller types in both years as well as whole plant samples of cv 'Pete'. There was better forage quality with the shorter second cutting interval (Table 2). The average of the 1st cuttings on 6/13/97 and 6/4/98 was 14.7, 70.7, 32.5, 3.0, 80.7 and 73.6 percent for CP, NDF, ADF, lignin, IVTD and dig. NDF respectively. Although the percent fiber as measured by NDF was high the digestibility of that fiber and the total digestibility was very high.

Table 1. Influence of harvest date on forage quality parameters (g/kg) of eastern gamagrass, first cutting.

Harvest Date	NDF[1]	ADF	Lignin	IVTD	dNDF	CP
1997						
June 13	693^{a2}	312^{a}	33^{a}	798^{a}	727^{a}	163^{a}
June 20	773^{b}	381^{b}	62^{b}	751^{b}	668^{ab}	164^{a}
June 27	770^{b}	396^{b}	68^{b}	752^{b}	673^{b}	159^{b}
1998						
May 29	709^{a}	319^{a}	23^{a}	843^{a}	778^{a}	135^{a}
June 4	721^{b}	338^{b}	26^{a}	815^{ab}	744^{ab}	131^{a}
June 12	746^{b}	355^{c}	30^{b}	794^{b}	724^{b}	130^{a}

[1]NDF=neutral detergent fiber, ADF=acid detergent fiber,
IVTD=in vitro true digestibility, dNDF=digestible NDF, CP=crude protein.
[a,b,c] Least squares means in the same column and year with different superscripts differ ($P < 0.05$). [2]To convert g/kg to %, multiply by 0.1

Table 2. Influence of harvest date on forage quality parameters (g/kg) of eastern gamagrass, second cutting.

Hdi[1]	CI[2]	NDF	ADF	Lignin	IVTD	dNDF	CP
6/13/97	4 wk	705[3]	354	43	777	684	128
	5 wk	708	366	46	717	601	109
	6 wk	733	379	51	698	589	106
6/20/97	4 wk	711	364	49	728	617	121
	5 wk	726	367	48	705	594	127
	6 wk	719	371	49	698	582	100
6/27/97	4 wk	711	355	47	770	677	134
	5 wk	699	341	44	744	634	124
	6 wk	681	335	43	739	618	123
5/29/98	4 wk	743	354	41	815	751	159
	5 wk	723	357	32	793	713	126
	6 wk	722	364	29	747	647	108
6/4/98	4 wk	715	345	31	818	745	129
	5 wk	713	359	29	782	694	113
	6 wk	735	409	40	742	649	82
6/12/98	4 wk	726	361	32	778	694	119
	5 wk	728	395	39	761	679	101
	6 wk	738	422	52	729	634	80

[1]Hdi =initial harvest date, [2]CI =cutting interval [3]To convert g/kg to %, multiply by 0.1

Companion Planting

Yield of eastern gamagrass with interseeded legumes

Paul Salon, Research Agronomist, USDA NRCS, Big Flats Plant Materials Center, Corning, New York.

Companion planting with legumes would be beneficial when growing eastern gamagrass for reducing erosion, adding nitrogen, improving yield and quality and for weed control. Eastern gamagrass is slow to establish and is grown in rows 30-36 inches wide. This study evaluates the performance of 'Pete' eastern gamagrass and 6 companion crops when grown in 3 locations in New York State.

The 3 sites were: Cornell T&R center in Dryden, NY at an elevation of 400 m on a Howard gravelly silt loam, 0-2% with a pH of 6.7 with high P&K soil test levels, planted 4/29/98. Cobleskill Ag. & Tech. College in Cobleskill, NY at an elevation of 290 m on a Tioga silt loam, 0-2% with a pH of 6.7 with high P&K soil test levels, planted 5/18/98. Rogers Center in Sherburne, NY at an elevation of 500 m with a southern aspect on a Valois gravelly silt loam, 6-8% with a pH of 6.4 with high P&K soil test levels, planted 5/22/98.

'Pete' eastern gamagrass was used for the study. The gamagrass was planted at 5-6 seeds/ft or approximately 15 bulk lbs/ac using corn planters at a depth of 1.5 – 2.0 inches with row spacing of 30-32 inches. Within the field plantings small plots of 5 rows by 30 ft were sown to companion crops following cultivation in late July. There were 4 replications per site in a randomized block design.

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The companion crops were: 'George' black medic, 'Randolf' red clover, and common Dutch white clover at 10 lbs/ac; 'Flagship II alfalfa 15 lbs/ac, 'Norcen' birdsfoot trefoil 12 lbs/ac and 'Astro' oats 2 bu/ac.

There were significantly higher eastern gamagrass yields in the area outside of the study areas which had an early spring dormant Round-up treatment and 2,4-D in the spring to help control broadleaf weeds. The eastern gamagrass yields in these areas at Cornell, Cobleskill and Rogers Center for two cuttings in 2000 (a very cold year) were: 2.11, 2.99, and 2.75 tons/ac dry matter respectively. Cornell was cut one week earlier than the Rogers Center and was on very well drained soils, which may have been effected by the previous years drought.

The perennial companion crops competed with the eastern gamagrass reducing yields compared to the control. There were significantly lower gamagrass yields on the drier location at Cornell for alfalfa, white clover and red clover companion plots for both cuttings and birdsfoot trefoil for only the first cutting. The other sites were not significant at P=.05 but the trends for the gamagrass yields were the same for the alfalfa and white clover companion plots. The percent of yield compared to the control for the alfalfa, black medic, oats, red clover, birdsfoot trefoil and white clover in 1999 (a very dry year) was 58%, 73%, 100%, 60%, 79% and 58% respectively. The percent yield reduction for the white clover, red clover and alfalfa in 2000 was 69.7, 86.7 and 71.3 %.

The legumes got a 4-6 week head start on the gamagrass in the spring resulting in moisture competition, shading and a cooler microclimate. Although the legumes reduced gamagrass yields **total yields were increased** by the legume component compared to the gamagrass grown alone. The **oats were not competitive** with the gamagrass and provided excellent winter cover for erosion control and potential frost heaving protection.

All of the companion crops established well and provided good erosion control in the fall and winter. There were a lot of annual weeds that provided some erosion control earlier in the season.

These weeds were controlled by the cultivation conducted just prior to seeding. There was no competition between the companion crops and the gamagrass during the establishment year (1998). The second year (1999), due to a drought, there was above normal competition. The white and red clover provided the most cover between the rows at 96% when evaluated in mid June 2000. The alfalfa and birdsfoot trefoil did well at all sites (74 & 75%).

There was a positive relationship between the cover of the companion crops and annual weed suppression but the companion crops were also competitive against the eastern gamagrass. As the covers decline weed infestation becomes a problem which may need an herbicide application to control. The establishment of companion crops during the second year may be an option on soils not prone to erosion to avoid competition during the second year.

Project Report

Eastern gamagrass for forage, soil improvement and buffer strips

October 1999 to September 2000 status report. Project led by Donald T. Krizek, Sustainable Agricultural Systems Laboratory, USDA Agricultural Research Service, Beltsville, Maryland.

Detailed information on the growth responses, root penetration, forage quality, and yield of eastern gamagrass to acid, compact, aluminum toxic soils

will help to elucidate the physiological and morphological basis for its adaptation to restricted soils and demonstrate its potential as a forage crop and its value as a buffer in reducing runoff of sediment and nutrients from farmland into adjacent streams.

Evaluation of comparative performance of eastern gamagrass and other warm season grasses on demonstration and research plots on different soils and hydrologic sites throughout the state and dissemination of this information through field days, videos, and handouts on sustainable agriculture will provide farmers and researchers with a valuable data base.

Our findings have stimulated considerable interest among farmers and seed companies. Experiments to date indicate that eastern gamagrass is well adapted for growth on marginal soils of the Mid-Atlantic Region, but further studies are needed to address the problem of poor seedling establishment because of erratic germination and weed competition.

The ability of **eastern gamagrass** to produce relatively **high yields under restricted soil conditions and to cope with droughts** that are greatly limiting to yields of forage crops, such as alfalfa, and agronomic crops, such as corn and soybean, makes it a highly promising warm season grass**.**

A three year study on yield and root development of eastern gamagrass stands grown on a restricted soil

D.T. Krizek, J.C. Ritchie, A.M. Sadeghi, E. G. Rhoden, J.R. Davis, and C.D. Foy. 2000 Annual Meeting American Society of Agronomy Abstracts, p. 310. 2000.

A three-year field study (1997 to 1999) was conducted to determine the response of eastern gamagrass (cv. Pete) to pH, bulk density, and depth of topsoil on six sites of a loam soil.

Despite severe drought in all three years, total yield from two cuttings ranged from 2.4 to 6.0 Mg/ha in 1997 and 2.9 to 7.1 Mg/ha in 1998. In 1999, only one cutting was obtained in July which yielded 1.1 to 3.5 Mg/ha.

In general, **yields varied with position on the slope, bulk density, and depth of topsoil, but not with pH.** Sites at the base of the slope out-yielded those at the top and tended to have lower bulk density, lower penetrometer resistance (PR), and greater topsoil depth. Overall, bulk density increased with depth; the average bulk density of the six sites at 0-15, 15-30, and 30-45 cm was 1.3, 1.6 and 1.7 g/cm3, respectively. Root dry weights were reduced at depths below 15 cm, where bulk density was the highest. PR readings at site 1 (plowed) averaged 2.2 MPa, while the averages at the other five sites (no-till planted) ranged from 4.3 to 4.8 MPa.

The capacity of **eastern gamagrass to survive moisture stress may be attributed to its ability to develop deep penetrating roots in restricted soils** early in the season, thereby providing a drought-avoidance mechanism.

A three-year study on forage quality and composition of eastern gamagrass stands grown on a restricted soil

D.T. Krizek, J.B. Reeves, III, J.C. Ritchie, A.M. Sadeghi, and C.D. Foy. 2000 Annual Meeting American Society of Agronomy Abstracts, p. 97. 2000.

The objective of this research was to investigate the effect of depth of topsoil and pH on the fiber

composition and digestibility of eastern gamagrass grown at the Beltsville Agricultural Research Center, Beltsville, MD. Samples were collected in 1997, 1998, and 1999 from eastern gamagrass (cv. Pete) plants grown on a slope with decreasing depth of topsoil from bottom to top. It should be noted that in all three years plants experienced severe drought.

Samples were dried at 60 C, ground in a 20 mesh Wiley mill, and analyzed in duplicate for neutral and acid detergent fiber (NDF and ADF, respectively), 72% sulfuric acid lignin (ADL), NDF, dry matter (DM) *in vitro* digestibility, and total crude protein. In 1997, results showed that with decreasing depth of topsoil, resulting plants contained less fiber (NDF and ADF) and were more digestible, as evidenced by increased NDF and DM digestibility. However, in 1998, except for ADF, samples obtained from the same locations, did not show these same trends (drought conditions were even more severe).

Soil pH had no significant effect on gamagrass forage composition. Thus, marginal soils do not appear to have any detrimental effects on the forage composition or quality of eastern gamagrass.

Effect of eastern gamagrass on infiltration rate and soil physical and hydraulic properties

Christopher Perrygo, Master of Science Dissertation., 2000. Department of Biological Resource Engineering, University of Maryland, College Park, Maryland.

Many processes are known to contribute to macropore development and flow in the vadose zone. Experimental data have been collected on the ability of vegetation and organisms such as earthworms to enhance soil properties. However, minimal research has been conducted on the effects of eastern gamagrass on infiltration and soil hydraulic and physical properties.

Field and laboratory experiments were conducted on field plots of eastern gamagrass and tall fescue to quantify the effect on infiltration and soil hydrologic properties in the Coastal Plain soils of Maryland. **Eastern gamagrass was compared with tall fescue to evaluate the effectiveness in reducing runoff in agricultural buffer strips.** The field plots are located at the USDA-BARC North farm near Beltsville, Maryland.

First, *in situ* measurement of cumulative infiltration was performed in the field. Second, soil samples were collected and saturated hydraulic conductivity was measured in the laboratory. Next, the soil samples were used to determine the soil water characteristic curves. Finally, bulk density was determined for each soil sample. The experiment was replicated quarterly during 1998 (February, May, August, November) at the soil surface and at 30 cm below the soil surface.

A tension infiltrometer was used to conduct *in-situ* infiltration tests at 0 tension (indicative of macropore flow) and -5 cm tension (indicative of matrix flow). The results indicated a greater infiltration beneath eastern gamagrass as opposed to tall fescue at the soil surface and at a depth of 30 cm under pressure heads of 0 and -5 cm during each quarter.

Three-inch soil core samples were collected from the field plots of eastern gamagrass and tall fescue at the soil surface and at a depth of 30 cm during each quarter. Saturated hydraulic conductivity for the eastern gamagrass soil samples were higher compared to the soil samples from tall fescue. The soil water characteristic curves of eastern gamagrass displayed were indicative of favorable conditions as opposed to the tall fescue.

The bulk density of the eastern gamagrass soil samples was determined to be lower than that of the soil samples from tall fescue. These results were consistent at the soil surface and at 30 cm below the soil surface. Although seasonal differences were observed, similar results were concluded for each quarter.

This study concluded that **eastern gamagrass increased the infiltration of water and improved soil physical and hydraulic properties in the Coastal Plain soils of Maryland.** Eastern gamagrass is suggested for planting in agricultural grass hedges and buffer strips.

Eastern gamagrass root penetration in adverse subsoil conditions

R. E. Gilker, R. R. Weil and D. T. Krizek. USDA Agricultural Research Service, Beltsville, Maryland and University of Maryland, College Park, Maryland. 2000.

Eastern gamagrass [Tripsacum dactyloides (L.) L] is reported to exhibit acid tolerance and root penetration through claypans. To study its root growth in these conditions, a greenhouse column study was conducted at USDA BARC, using sordan [Sorghum x drumondii (Steud.) Millsp. & Chase] as a comparison species.

Treatment factors were: soil water (-10 and –300 kPa), soil pH (3.5 and 4.8), and soil bulk density (1.3 and 1.7 g cm^{-3}). The treatments were applied to aluminum toxic Tatum B_t horizon material used in the middle 30 cm section of 15 X 60 cm polyvinylchloride columns. Soil strength was determined at harvest by cone penetrometer resistance.

Eastern gamagrass tolerated acid, aluminum toxic conditions, while sordan did not (Figure 1). Eastern gamagrass roots **appeared to be inhibited by low air-filled porosity in dense soils** (1.15 $\pm$ 0.5 MPa), but were **able to penetrate high soil strength layers** (1.88 $\pm$ 0.76 MPa) that inhibited sordan root growth (Figure 2). These characteristics make eastern gamagrass valuable in establishing grassed buffers, vegetative conservation barriers and pastures in extremely acid or dense soils.

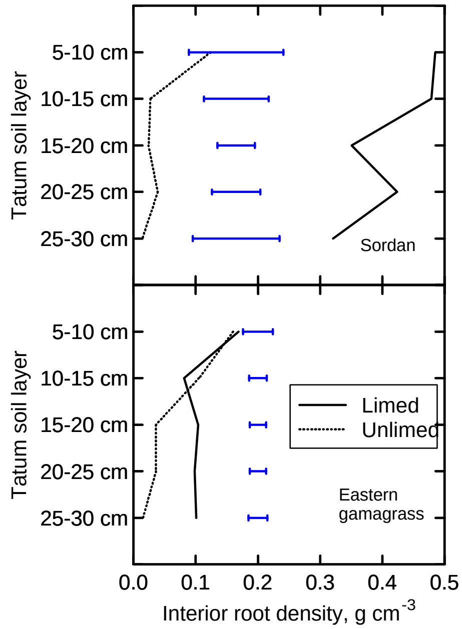


Figure 1: The effect of liming on eastern gamagrass and sordan interior root density through the test section. Bars denote 1 SE (standard error).

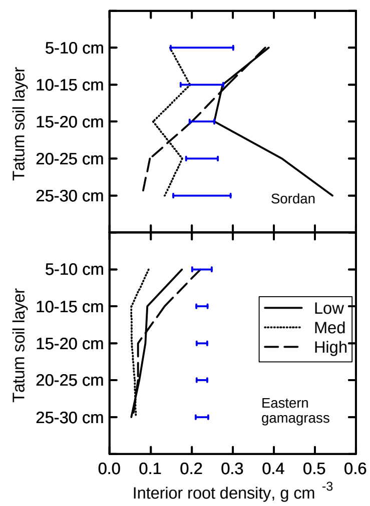


Figure 2: The effect of soil strength on eastern gamagrass and sordan interior root density through the test section. Bars denote 1 SE.

Weeds

Eastern gamagrass establishment with herbicides

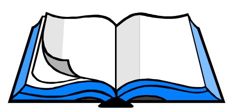
C.B. Coffman, and L. R. Vough. Presentation at the 55th meeting of the Northeastern Weed Science Society, Boston, Massachusetts. January 2001.

Eastern gamagrass [*Tripsacum dactyloides* (L). L.] is a native perennial, warm-season bunch grass having desirable production and nutritional properities. This forage grass can be grown across a wide range of soil conditions and provides more feed production than cool-season grasses and legumes during hot, dry summers. However, eastern gamagrass tends to establish slowly and thus is susceptible to severe competition from annual weeds. Although eastern gamagrass has demonstrated tolerance to several corn herbicides, **there are presently no herbicides labeled for use with this forage**. This investigation was established to develop preliminary information concerning the tolerance of eastern gamagrass to selected herbicides prior to submission of requests to IR-4 for establishment of research projects pursuant to obtaining national label registrations.

Eastern gamagrass seed was sown in 30-inch rows on 10 June, 1999, into standing rye using a no-till corn planter. The seeding rate was 10 lb/A and seed were sown 1.5 inches deep. Fertilizer was applied according to soil test recommendations. The rye was flail mowed prior to the application of herbicide treatments, which were applied five days after seeding (DAS).

Preemergence (PRE) treatments were replicated three times and included the following herbicides and rates: s-metolachlor/atrazine (Bicep II Magnum, 2.5 qt/A), flumetsulam (Python, 1.3 oz/A), dimethenamid plus atrazine (Frontier plus Aatrex Nine-O, 1.7 pt/A plus 1.1 lb/A), alachlor plus atrazine (Microtec plus Aatrex Nine-O, 3 qt/A plus 1.8 lb/A), and acetachlor plus atrazine (Harness plus Aatrex Nine-O, 1.75 pt/A plus 1.1 lb/A). Plots were 14 by 40 feet. The research area was not irrigated and rainfall totals were approximately one inch by 14 DAS.

Visual estimates of weed cover and crop stand were made in late August, 1999, nearly 30 days after gamagrass seed germination. **Weed cover ranged from 30 to 60 percent and crop stand ranged from 40 to 60 percent.** Gamagrass in plots treated with flumetsulam were slightly shorter than plants in the other treatments, and also had the lowest estimated stand. A postemergence application of 2,4-D plus dicamba (0.25 pt/A plus 0.50 pt/A) was made across all treatments including the controls in May of 2000 to manage perennial broadleaf weeds. All plots were mowed to six inches on 7 July, 2000, with plant material removed from the field. Crop and weed biomass were obtained following 4 weeks of regrowth. Lowest crop yields and highest weed yields were in the untreated controls. Gamagrass yields from PRE herbicide treated plots ranged from 611 g/m^2 to 958 g/m^2 for dimethenamid plus atrazine and alachlor plus atrazine treatments, respectively.



Glossary

Aggregate development and Aggregate stability are good soil quality indicators. With the addition of organic matter microorganisms produce chemical breakdown products and mycelia that bind individual soil particles into natural aggregates. The principle forms of soil structure: granular, prismatic, blocky, and platy are the results of how aggregates align with each other. The spaces between the aggregates provide pore space for retention and exchange of air and water.

Aggregate stability refers to the ability of soil aggregates to resist disruption when outside forces (usually water) are applied. Aggregates that disintegrate release individual soil particles that can clog surface pores and drastically reduce air and water entry into the soil. Surface crusting due to aggregate disintegration reduces infiltration, increases runoff and the hazard of soil erosion.

Bulk Density is the mass of dry soil per unit of bulk volume, including the air space. The bulk volume is determined before drying to constant weight at 105 degrees C.

Permeability, Saturated Hydraulic Conductivity, is influenced by texture, structure, bulk density, and large pores. Soil structure influences the rate of water movement through saturated soil, in part, by the size and shape of the pores. Granular structure readily permits downward water movement, prismatic and blocky structures moderate resistance and platy structure increased resistance to drainage.

Soil organic matter includes plant and animal remains in various stages of decomposition, cells and tissues of various soil organisms, and substances from plant roots and soil microbes. In most soils, the organic matter accounts for less than 5% of the volume. It encourages aggregate stability and good tilth, increases porosity, lowers bulk density, promotes water infiltration and increases available water for plants.

Project Participants

Initial contacts concerning the project may be directed to the following persons, however the list of participants is much longer:

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Photo taken by Dr. Donald Krizek, USDA Agricultural Research Service. June 21, 2000. Eastern gamagrass at the Beltsville Agricultural Research Center, Beltsville, Maryland.